Valve Preamplifier (2a)

Part 2a: Construction (continued) and test data

By G. Haas

Once you've stuffed all the boards that go into the design, the Valve Preamplifier is ready for assembling and wiring. The results (see pictures and performance data) are pretty convincing.

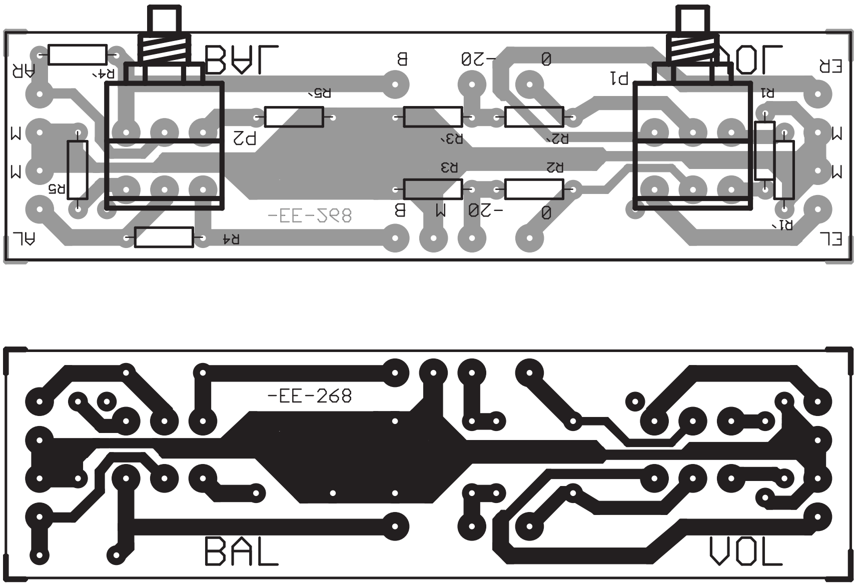
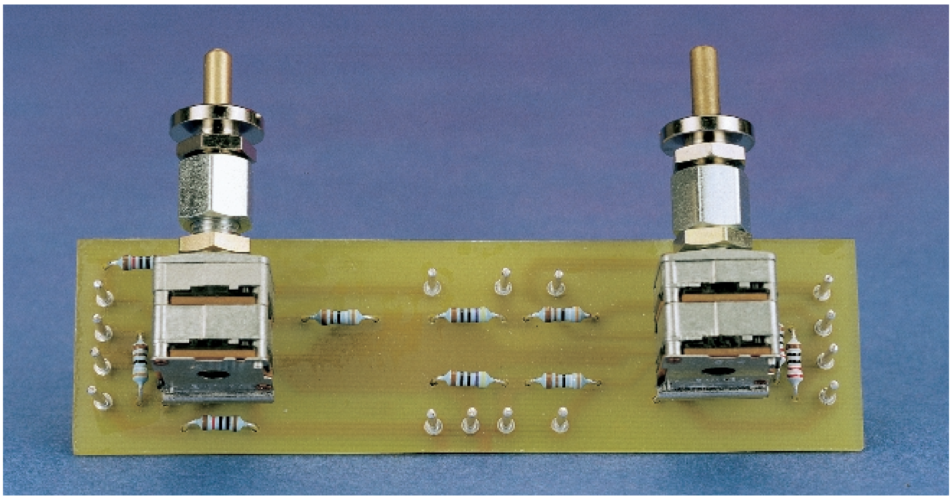


Figure 2. The small printed circuit board for the volume and balance controls.



Next comes the volume control board (see **Figure 2**). The photograph shows how it is built. There is nothing difficult about mounting the components, and the board can be solidly attached to the front panel via the potentiometers, using suitable hardware.

The output relays and the headphone socket are mounted on the small circuit board shown in **Figure 5**. The socket is also used to fix the board to the chassis, so no additional fitting hardware is needed. You must pay careful attention to where the signal from the amplifier comes from and where is it goes to afterwards. The headphone socket is protected only if the wiring is done properly. In addition, make sure that

COMPONENTS LIST

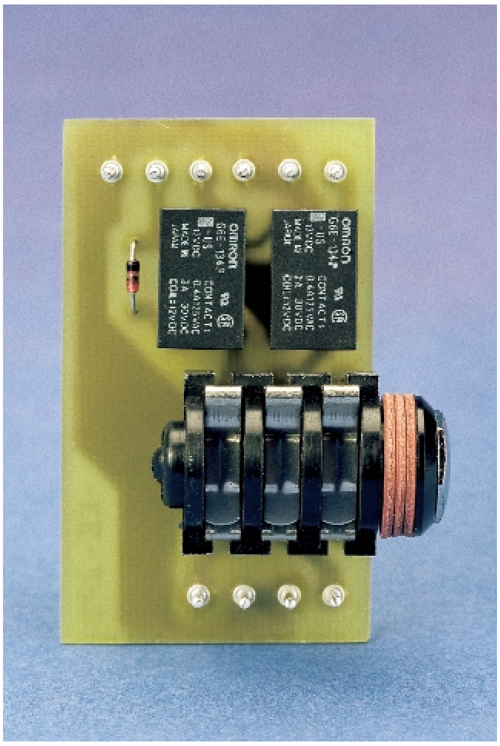
Volume Control

Resistors:

R1,R1′ = 100Ω
R2,R2′,R4,R4′ = 3kΩ9
R3,R3′ = 470Ω
R5,R5′ = 10kΩ
P1 = 10kΩ stereo potentiometer, linear, tracking
P2 = 10kΩ stereo potentiometer, linear, tracking
2 holders for potentiometers

Miscellaneous:

S1 = rocker switch, 2 poles, 3 contacts
Solder pins



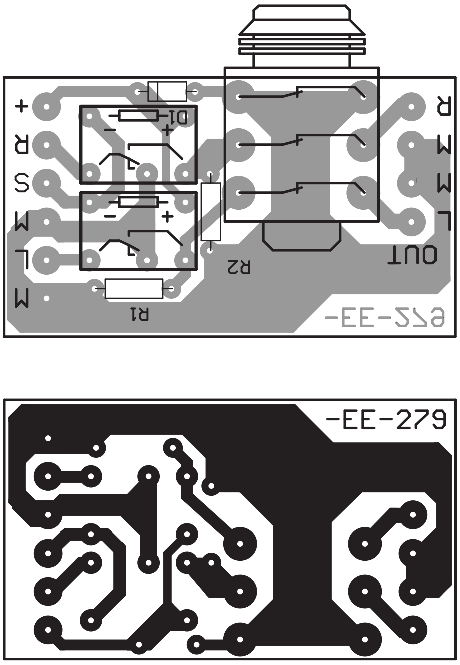


Figure 5. The small printed circuit board for the output relays and headphone socket.

COMPONENTS LIST
Headphones/Line Switch

K1 = stereo headphones socket, PCB mount
Re1,Re2 = relay, 1 changeover contact, 12V coil (Omron G6E)
R1,R2 = 680kΩ

COMPONENTS LIST
High Voltage Supply

Resistors:
R1 = 10kΩ, 2W
R2 = 100Ω, 4.5W
R3,R4 = 1kΩ
R5 = 6Ω8, 2W
R6 = 150kΩ, 2W

Capacitors:
C1 = 100µF 400V, raster 10mm
C2,C3 = 22µF 400V, raster 7.5mm

Semiconductors:
T1 = BUZ92
T2 = BC546
D1,D2,D3 = zener diode 110V, 1.3W
D4 = zener diode 18V, 1.3W
GI1 = B500C1500, rectangular case (500V piv, 1.5A peak)

Miscellaneous:
Heatsink for T1: SK 68/50 (Fischer, Dau Components)
Isolation and mounting material for T1 and heatsink
Solder pins

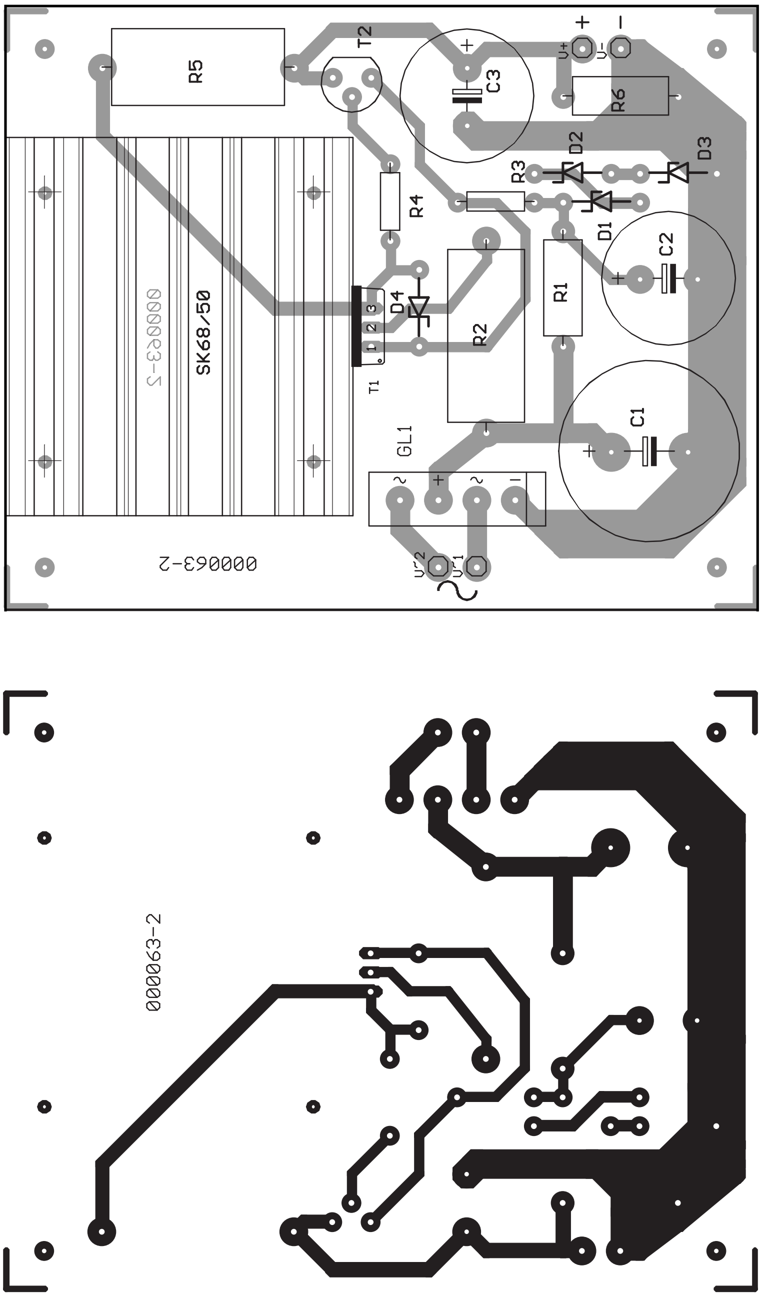


Figure 7. the high-voltage power supply and …

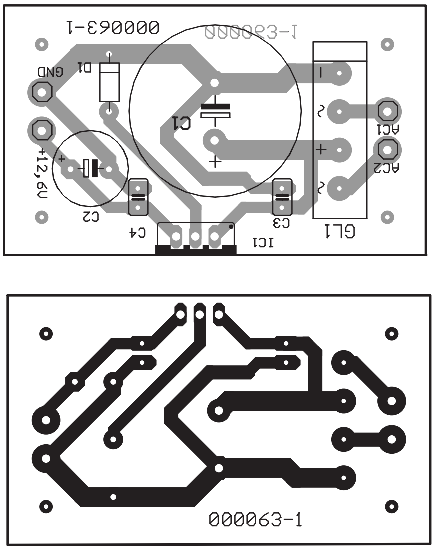


Figure 8. the low-voltage power supply.

COMPONENTS LIST

Low Voltage Supply

Capacitors:
C1 = 2200µF 40V, raster 7.5mm
C2 = 100µF 40V, raster 5mm
C3,C4 = 100nF, ceramic, raster 5mm

Semiconductors:
Gl1 = B80C1500, rectangular case (80V piv, 1.5A peak)
D1 = 1N4148
IC1 = 7812

Miscellaneous:
Isolation material for IC1
Si1,Si2 = fuse, 0.2 A, slow, with PCB mount holder
Solder pins

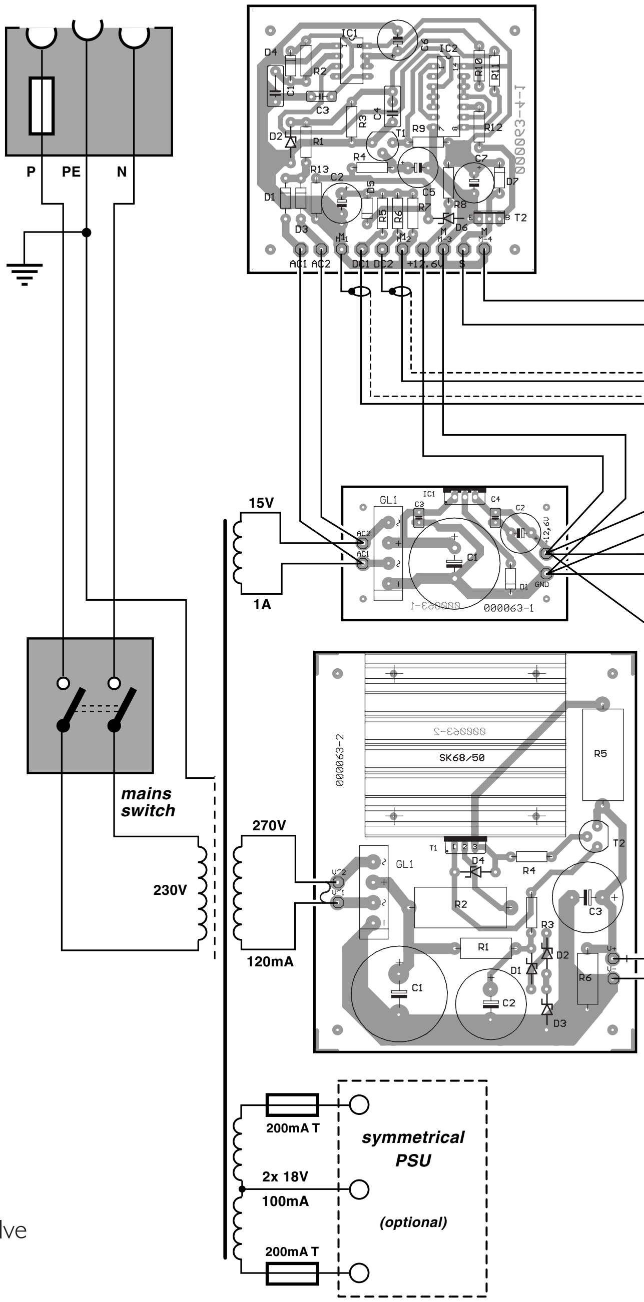


Figure 9. The wiring of the valve preamplifier is complicated.

the relays are correctly polarised, as shown on the component overlay. The selected relays are fully enclosed, which protects the contacts from contamination. In addition, the contacts are gold plated and rated for 250-V operation.

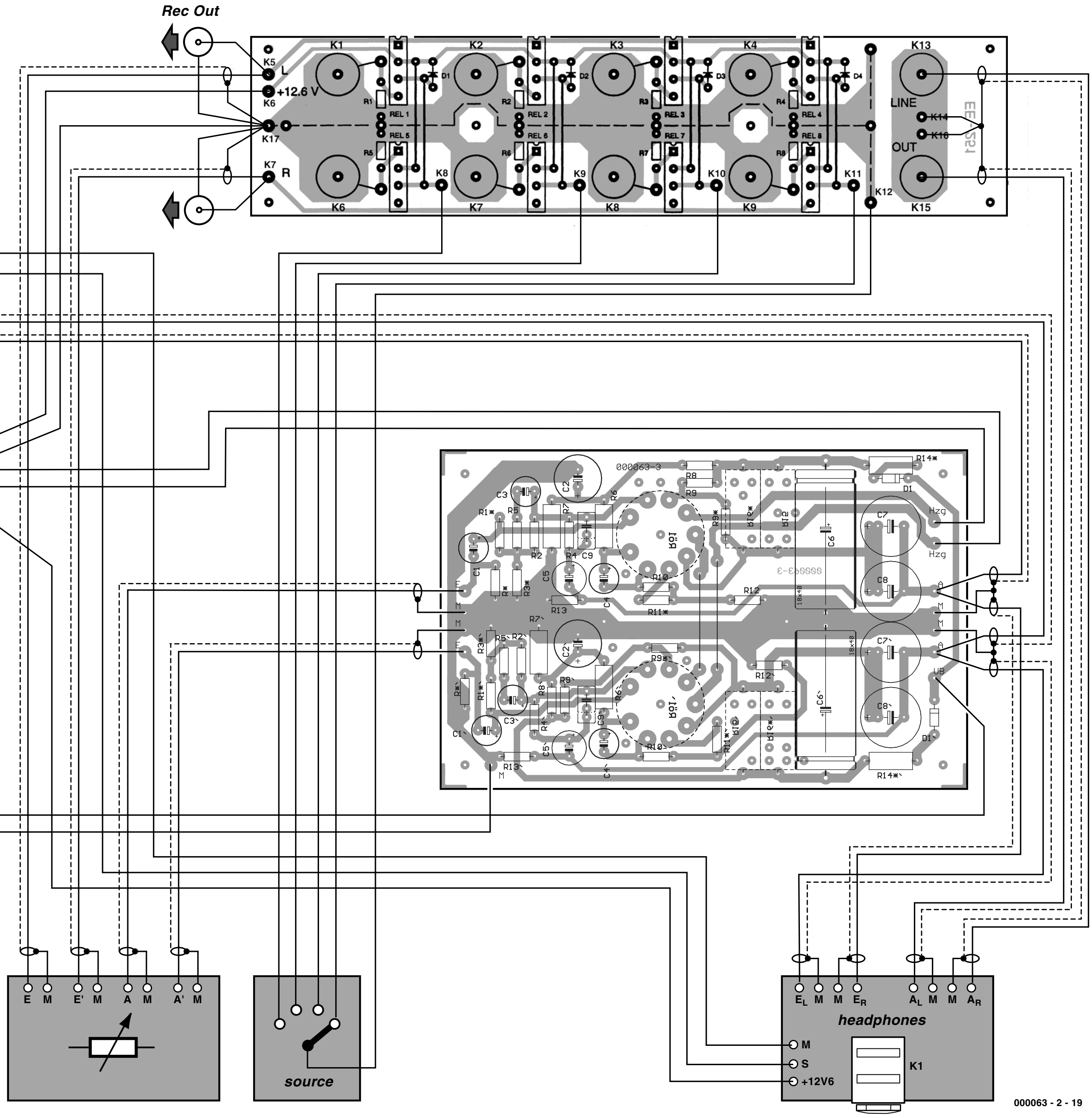
There is no circuit board available for the optional symmetric power supply. However, the rich store of *Elektor Electronics* projects should provide adequate possibilities.

Now that you have finished building all the circuit boards, they can be fitted into the enclosure. If you use the original enclosure, as described above, all of the necessary holes are pre-drilled, so all you have to do is to fit the hardware for the individual parts (including the mains cable input socket, the power switch, the potentiometers and the recorder sockets). If you prepare your own enclosure, take care to arrange the individual items in a favourable manner and ensure that the circuit boards are solidly attached. Don't fit the input module right next to the mains transformer, since otherwise you can be sure of introducing mains hum into the audio signals.

Internal wiring

Installing the wiring that interconnects the various circuit boards is probably the most complicated task of all. Consequently, we have prepared the wiring diagram shown in **Figure 9**. You should photocopy this, and mark each connection on the copied diagram once you have made the connection. This manner of working has proven to be the most foolproof, including in the *Elektor Electronics* labs.

All leads that carry audio signals must be made using good-quality screened cable. Ordinary light-duly multi-strand wire can be used for the remaining leads, which consist of the signal source selector switch wiring, the protection circuit wiring and the power supply wiring. The wire should have a diameter of 1 mm and good insulation. Place the signal wiring and the other wiring so that the two types are separated from



each other as far as possible, and fix the cables to the chassis using clips. Connect the recorder output sockets to the common busses for the other circuit boards using wire bridges.

The moment of truth

When you have finished the wiring and everything has been checked and rechecked, you are ready to try the first functional test. First, break the connection between the mains transformer and the high-voltage circuit board (and insulate it against accidental contact). The filament supply must measure 12.6 V as soon as it is switched on, and it must be short-circuit proof. This voltage may vary by up to ±5 percent. The valve filaments must glow visibly after around one to two minutes. Later on, the filaments will be the 'pilot light' for the preamplifier. However, if you want an additional, more distinct power-on indicator, you can simply connect an LED in series with a resistor and 1N4007 diode to the 15-V winding of the mains transformer. You can also right away check the operation of the relays.

After this initial test, you can activate the high voltage. It should reach its nominal value shortly after being switched on. If nothing smokes, check the expected values noted on the schematic diagram. After this, use a sine-wave generator and oscilloscope to check the audio paths and functions. Once this test has been successfully completed, close up the enclosure, connect the preamplifier to signal sources and a final amplifier, and switch everything on. A valve cathode must warm up for two to five minutes before it can emit enough electrons for the valve to be operational. However, you will have to wait around ten to twenty minutes for the valve to be thoroughly warmed up, before you will hear the 'right' sound. After this, all you have to do is relax and enjoy what you hear!

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Measured performance

We made our own measurements of the performance of the valve preamplifier in the Elektor laboratories. Naturally, we would like to share the results with you. The ‘raw’ numbers are listed in the table. All measurements were made after a four-hour warm-up interval, with an effective input voltage of 1 V and an effective output voltage of 2 V. The outputs were terminated in 10 kΩ, and free inputs were terminated in 600 Ω. The balance potentiometer was in the middle position.

Signal to noise ratio	**A-weighted**	**100 dBA**
	linear, 22 Hz – 22 kHz	87 dB
THD plus noise	1 kHz, BW = 80 kHz	<0.05 %
	1 kHz, BW = 22 Hz – 80 kHz	<0.01 %
	1 kHz, BW = 400 Hz – 22 kHz	<0.05 %
IMD	(50 Hz : 7 kHz = 4:1)	<0.02 %
DIM	(3.15 kHz square wave + 15 kHz sinusoid)	0.003 %
Channel separation	1 kHz	84 dB
	20 kHz	63 dB
Crosstalk	1 kHz	<–115 dB
	20 kHz	<–93 dB
Input impedance	Minimum volume	6.4 kΩ
	Maximum volume	2.1 kΩ
Output impedance		<200 Ω
Amplification factor		2.54
Bandwidth		3.5 Hz - 500 kHz
Balance adjustment range		+3 to - 4.7 dB
Attenuator		18 dB
THD	Output voltage = 50 V_{eff}	0.1 %

It must be noted that the measurements were made without any screening of the valves, so RF disturbances from the measurement environment (Elektor lab with PC-based measurement equipment) may have influenced the measured results. If RF interference sources are present in the vicinity of the preamplifier, screens should be provided for the valves.

The five measured performance curves show the following:

A) Amplitude response

On the strongly enlarged scale up to 200 kHz, (the upper performance limit of our audio generator), a slight rise in the amplitude response can be seen. Within the ‘interesting’ part of the audio frequency band, the curve is dead straight!

B) Channel separation

The curves are self-explanatory; the two channels track each other very nicely. These curves start at 200 Hz, in order to eliminate the effect of power supply ripple on the measurements.

C) Frequency spectrum

The effect of power supply ripple can be seen in the frequency spectrum. The spectrum of this ripple reaches to around 800 Hz. This explains the relatively large difference between the A-weighted and linear measurements (100 dBA and 87 dB, respectively). With the 1-kHz tone (1 V_{eff}), essentially only the second harmonic is visible, reaching up to –90 dB. The influence of interference signals, which in this case come from some old monitors located near the amplifier, can be seen with the unscreened valves as peaks in the high-frequency region of the spectrum (30 kHz and 60 kHz).

D) THD plus noise

This curve was obtained with a bandwidth of 22 Hz to 80 kHz. The interference signal components come from the effects of power supply ripple, and probably also from induced signals radiated by the transformer.

E) Step response

A squarewave signal at the input (10 kHz, 1 V) produces a small overshoot (around 10 percent) at the output.